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Comparative study on developing metacognitive abilities of students from technical, vocational and human sciences

Gianina-Ana Masari [a] , Ona Anghel [b]

[a]*Alexandru Ioan Cuza University, Faculty of Psychology and Education Sciences, Bd. Carol I no. 11, Iasi, 700506, Romania*
[b]*Gh. Asachi Technical University, Teacher Education and Training Department, Bd. Dimitrie Mangeron no. 67, Iasi, 700050, Romania*
[c]*Third affiliation, Address, City and Postcode, Country*

Abstract

The purpose of study is to outline differences of learning abilities developed into university system between three categoria of students from technical, vocational and human sciences. The qualitative research instrument chosen to carry out the research was a structured questionnaire. In qualitative terms, data were structured on six dimensions: 1) types of activities ; 2) most used types of strategies for development of metacognitive abilities; 3) most used metacognitive abilities; 4) control and adjustment of mental processes; 5) knowledges regarding tasks for development of metacognitive abilities; 6) most used strategies for knowledges based on algorithmical or an heuristical approach.

Keywords: metacognitive, abilities, knowledge, development, students;

1. Introduction

Most students need guidance into learning process. Educational succes is influenced by learning style and developed abilities. If a student does not mastered very well the steps of the learning process, he will learn only from that perspective. The term "metacognition" has been linked to intelligence (Borkowski, Carr, & Pressley, 1987; Brown, 1987; Sternberg, 1986), and it refers to higher order thinking which involves active control over the cognitive processes engaged in learning. Therefore, teachers are responsible to teach students how to learn. Developing metacognition, it allows us to be successful learners. Teachers have to make the students to realize that decisions can be based on not just characteristics of the input problem, but a good choice involves knowledge about algorithm performance. Studying metacognitive activity and its development to determine how students can be taught to better apply their cognitive resources through metacognitive control is a required task for teachers. If we look from this perspective, we can say that metacognition plays a critical role in successful learning, therefore it is closely related to authentic assessment and holistic learning. Metacognition enables students to benefit from instruction (Carr, Kurtz, Schneider, Turner & Borkowski, 1989). H. M. Wellman (1983) considers that metacognition differs from standard cognition in that the self is the referent of the processing or the knowledge. Therefore, teachers should be aware of the implications and consequences of the teaching act, because their performance of teaching allows development of metacognition abilities of their students. Teachers should vary types

1 Gianina-Ana Masari. Tel.: +00-40-741-071601; fax: +0040232-21066
E-mail address: gianina.massari@gmail.com

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of activities, to follow the most used types of strategies for development of metacognitive abilities; to monitorize the most used metacognitive abilities; to control and adjustment of mental processes; to provide knowledges regarding tasks for development of metacognitive abilities; and to allow development for most frequent used strategies for knowledges based on algorithmical or an heuristical approach. Analysis of these dimensions aims to optimize the learning process, organization and self-adjustment of students' behavior to directions, goals, becoming more strategic, more autonomous in managing learning tasks and problem solving, better able to compensate the weaknesses of the other levels and to improve their learning outcomes.

2. Purpose of study

The purpose of this study is to outline differences of learning abilities developed into university system between three categoria of students from technical, vocational and human sciences.

3. Research Methods

According to the hypothesis of this article, we assumed that there are significant differences on the development of metacognitive training between students from pedagogy of kindergarten and primary school teachers, psychology, computer science, veterinary medicine, and biology faculties. Regarding variables, we considered the questionnaire items as dependent variables and students' university specialization as an independent variable. The questionnaire was applied in paper and electronically version on 281 students, divided into 5 groups as follows: group no. 1 – 83 students of the Faculty of Psychology, group no. 2 – 38 students from Pedagogy of Kindergarten and Primary School Teachers; group no. 3 – 51 students from Faculty of Computer Science, group no. 4 – 64 students from Faculty of Veterinary Medicine, and group no. 5 – 45 students from Faculty of Biology. Data collected were processed statistically using SPSS 11. One Way ANOVA analysis of variance and Tukey HSD test were performed to explore differences in students' academic specialization data to achieve metacognitive training. To verify the hypothesis there was developed a structured questionnaire with 25 items classified into six dimensions: 1. types of activities; 2. most used types of strategies for development of metacognitive abilities; 3. most used metacognitive abilities; 4. control and adjustment of mental processes; 5. knowledges regarding tasks for development of metacognitive abilities; and 6. most frequent used strategies for knowledges which include an algorithmical or an heuristical approach. For a deeper analysis regarding differences of metacognitive training between students from different specialties, like Pedagogy of Kindergarten and Primary School Teachers, Psychology, Biology, Veterinary Medicine, and Computer Science, we used One Way ANOVA for each item of the questionnaire. Statistical analysis showed us that there significant differences overall metacognitive training on the following items: 1a: $F(4, 276) = 4,5$, $p= 0,001$; 1b: $F(4, 276) =5,3$, $p= 0,000$; 1c: $F(4, 276) = 11,3$, $p= 0,000$; 1d: $F(4, 276) = 7,2$, $p= 0,000$; 2a: $F(4, 276) = 7,1$, $p= 0,000$; 2b: $F(4, 276) =7,2$, $p= 0,000$; 2c: $F(4, 276) = 4,8$, $p= 0,001$; 3a: $F(4, 276) = 3,0$, $p= 0,016$; 3d: $F(4, 276) = 5,5$, $p= 0,000$; 3e: $F(4, 276) = 4,2$, $p= 0,002$; 4a: $F(4, 276) = 9,2$, $p= 0,000$; 4b: $F(4, 276) = 3,3$, $p= 0,010$; 4c: $F(4, 276) = 3,3$, $p= 0,011$; 4e: $F(4, 276) = 3,8$, $p= 0,005$; 4g: $F(4, 276) = 3,3$, $p= 0,011$; 5a: $F(4, 276) = 7,9$, $p= 0,000$; 5b: $F(4, 276) = 5,7$, $p= 0,000$; 5c: $F(4, 276) = 4,3$, $p= 0,002$; 5d: $F(4, 276) = 4,2$, $p= 0,002$; 6a: $F(4, 276) = 4,5$, $p= 0,001$; 6b: $F(4, 276) = 2,7$, $p= 0,029$.

4. Findings

To check the working hypothesis, there were selected only those results of statistical processing which have a threshold of significance, $p < 0.05$ which indicates significant differences between compared groups. In qualitative terms, data were structured on six dimensions: 1) types of activities (explanation, anticipation, self-evaluation and descentration); 2) most used types of strategies for development of metacognitive abilities (planning strategies, monitoring strategies, and adjustment strategies); 3) most used metacognitive abilities (understanding of goals and goal setting; understanding of the problem by identifying the essential elements; information and data representation; planning a solution; execution plan; checking the results by making self-queries); 4) control and adjustment of mental processes; 5) knowledges regarding tasks for development of metacognitive abilities; 6) most used strategies for knowledges based on algorithmical or an heuristical approach.

1. Types of activities

Explanation. There are significant differences between between students from Biology (M= 4.2667, SD= .98627) compared with those from Psychology (M= 3.6747, SD= 1.01343), Computer Science (M= 3.5490, SD= .98618), and Veterinary Medicine (M= 3.5781, SD= .93952).

Anticipation. There are significant differences between students from Biology (M= 3.7333, SD= 1.13618) compared with those in Psychology (M= 2.9277, SD= 1.18716), and Computer Science (M= 2.8039, SD= .95958).

Self-evaluation. There are significant differences between students from Biology (M= 4.3333, SD= .97701) compared with those from Pedagogy of Kindergarten and Primary School Teachers (M= 3.3158, SD= 1.06809), Psychology (M = 3.2892, SD = 1.13191), Computer Science (M= 2.9216, SD= .91309), and Veterinary Medicine (M= 3.5000, SD= 1.18187).

Descentration. There are significant differences between students from Biology (M= 3.6222, SD= 1.02888) compared with those from Pedagogy of Kindergarten and Primary School Teachers (M= 2.7632, SD= 1.26136), Psychology (M= 2.7831, SD= 1.14815), Computer Science (M= 2.4314, SD= 2.4314), and Veterinary Medicine (M= 2.6094, SD= 1.17672). Students from the Faculty of Biology have the highest average in perceiving the specific type of activities (explanation, anticipation, self-evaluation, and descentration) used in metacognitive training. Students from the Faculty of Computer Science registered the lowest scores on the use of descentration as a specific activity for the development of metacognition. Using this specific type of activity (descentration) where the teacher invites some students to compare the strategies used in a given task, it is below the average of 2.5 for students from the Faculty of Computer Science. And other types of specific metacognitive activities such as explanation, prediction or self-assessment are perceived by students from the faculty of Computer Science to be used less in their program of study than colleagues from other specialties.

2. Most used types of strategies for development of metacognitive abilities

Regarding the perception on using the development strategies of metacognition – planning strategies, control/ monitoring strategies and adjustment strategies, the students from Faculty of Biology have the highest average, while at the opposite side there are again the students from Faculty of Computer Science, they are the most demanding considering that metacognitive strategies are not enabled for them. Concerning the planning strategies, there are significant differences between students from Biology (M= 4.4222, SD= .69048) compared with those from Faculties of Pedagogy of Kindergarten and Primary School Teachers (M= 3.7105, SD= .98387), Psychology (M= 3.6988, SD= 1.04456), Computer Science (M= 3.4314, SD= .87761), and Veterinary Medicine (M= 3.6094, SD= 1.09279). No significant differences were recorded between the other groups. Regarding control/monitoring strategies, there are significant differences between students from Biology (M= 4.4000, SD= .86340) compared with those from Faculties of Pedagogy of Kindergarten and Primary School Teachers (M= 3.6316, SD= .97040), Psychology (M= 3.4819, SD= .90205), Computer Science (M= 3.4510, SD= .96569) and Veterinary Medicine (M= 3.5781, SD= 1.28242). No significant differences recorded between the other groups. About adjustment strategies, there are significant differences between students from Biology (M= 4.1111, SD= 1.04929) compared with those from faculties of Pedagogy of Kindergarten and Primary School Teachers (M= 3.4211, SD= 1.22213), Psychology (M= 3.3614, SD= 1.13243), Computer Science (M= 3.1961, SD= .77510), and Veterinary Medicine (M= 3.3281, SD= 1.30997).

3. Most used metacognitive abilities

Once again, there are differences between students from Faculties of Computer Science and Biology. Students from Biology registered significant differences on four levels from six followed regarding collecting methods used in the development of metacognition: understanding of goals and goal setting (M= 4.3556, SD= .77329); understanding of the problem by identifying the essential elements (M= 4.1333, SD= 1.07872); planning a solution (M= 4.0222, SD= .83907); and fulfillment of a plan (M= 3.9111, SD= 1.20269).

4. *Control and adjustment of mental processes*

During the the process of training, students considered that control and adjustment of mental processes are dealing with the following values as follows:

- facilitating the planning activities – students from the Faculty of Biology (M= 4.3111, SD= .82082) have the highest average, and students from the Faculties of Pedagogy of Kindergarten and Primary School Teachers (M=

3.6053, SD= 1.10379), Psychology (M= 3.3976, SD= .98699), Computer Science (M= 3.3529, SD= .84436), and Veterinary Medicine (M= 3.2656, SD= 1.07263) have the lowest average.
- facilitating the activities of estimating the expected result – students from the Faculty of Biology have the highest average (M= 3.8222, SD= .77720), and students from the Faculty of Psychology (M= 3.2771, SD= .88777), Computer Science (M= 3.1765, SD= 1.01402), and Veterinary Medicine (M= 3.2969, SD= 1.09370) have the lowest average.
- facilitating steps to achieve – students from the Faculty of Biology have the highest average (M= 4.0000, SD= 1.12815), and students from the Faculty of Veterinary Medicine have the lowest average (M= 3.3125, SD= 1.08196).
- facilitating surveillance activities / checking the effectiveness of ongoing process – students from the Faculty of Biology have the highest average (M= 3.7333, SD= 1.40454), and students from the Faculty of Computer Science have the lowest average (M= 3.0588, SD= .92546).
- facilitating the pursuit of a strategy – students from the Faculty of Biology have the highest average (M= 3.9556, SD= .97597), and students from the Faculty of Computer Science (M= 3.4902, SD= .94599), and Veterinary Medicine (M= 3.1719, SD= 1.07725) have the lowest average.
- facilitating the adjustment for a strategy – students from the Faculty of Biology have the highest average (M= 3.8667, SD= 1.23583), and students from Veterinary Medicine (M= 3.1250, SD= 1.20185) have the lowest average.

5. Knowledges regarding tasks for development of metacognitive abilities
Regarding the encouragement of students' opinions about the effects of task content there are significant differences between students from Computer Ccience (M= 3.1765, SD= 1.17823) compared with those students from Pedagogy of Kindergarten and Primary School Teachers (M= 3.8421, SD= 1.02736), Psychology (M= 3.7108, SD= 1.03039), and Biology (M= 4.4000, SD= .80904). Although there are small differences, there are significant differences between students from Biology (M=4.4000, SD=.80904) compared with those students from Psychology (M= 3.7108, SD= 1.03039), and Veterinary Medicine (M= 3.6563, SD= 1.22434).
About the encouragement of students' opinions about the task content, there are significant differences between students from Biology (M= 4.3111, SD= .82082) compared with those students from Psychology (M= 3.3976, SD= .98699), Computer Science (M= 3.3529, SD= .84436), and Veterinary Medicine (M= 3.2656, SD= 1.07263).
Concerning the encouragement of students' opinions about the structure of the task, there are significant differences between students from Biology (M= 4.1556, SD= .73718) compared with those students from Psychology (M= 3.3976, SD = .96318), Computer Science (M= 3.3529, SD= 1.11496), and Veterinary Medicine (M= 3.3281, SD= 1.15545).
Regarding the encouragement of students' opinions about the used terms, there are significant differences between students from Computer Science (M= 3.1569, SD= 1.15538) compared with those students from Psychology (M= 3.5904, SD= 1.01256), or Veterinary Medicine (M= 3.4063, SD= 1.15083), and Biology (M= 4.0000 , SD= .87905). No significant differences were recorded between the other groups. Students from the Faculty of Computer Science believe in a lesser degree than their peers that they have knowledge related to used terms, content, context task or its structure.

6. Most used strategies for knowledges based on algorithmical or an heuristical approach
There aren't significant differences between groups on perception of using strategies for knowledges based on heuristical approach. There are significant differences between students from Biology (M= 4.4667, SD= .81464) compared with those from Pedagogy of Kindergarten and Primary School Teachers (M= 3.7632, SD= 1.14925), and those from Veterinary Medicine (M= 3.5625, SD= 1.27086). No significant differences were recorded between the other groups. Instead there are differences regarding strategies for knowledges based on algorithmical approach, the students from Faculty of Biology believes that these strategies are used in a greater extent, while students from Faculty of Veterinary Medicine believes that such strategies are used in a more lesser extent, but their score is still above average.

5. Conclusions

There are significant differences for all variables that describe the metacognitive training: specific types of activity (F (4, 276) = 15.3, p. =, 000), strategies for development of metacognitive abilities (F (4, 276) = 10.0, p =, 000),

control and adjustment of mental processes (F (4, 276) = 7.8, p =, 000), knowledges regarding tasks for development of metacognitive abilities (F (4, 276) = 7.4 , p. =, 000), strategies for knowledges based on algorithmical or an heuristical approach (F (4, 276) = 3.6, p. =, 007). All data outlined the purpose of this study regarding the differences of learning abilities developed into university system between three categoria of students from technical, vocational and human sciences. Students from vocational departments registered the highest scores, followed by those from human sciences, and finally by those from technical speciality. This fact might draw attention to the teachers for taking into account to increase development of metacognitive abilities of their students. The answers of students from the vocational departments proved that they are aware about cognitive and metacognitive strategies, the knowledge about strategy variables, and conditional knowledge about when and where it is appropriate to use such strategies. Students from the humanities departments should develop their metacognitive training even more as they become future teachers and they will work themselves with students who have to develop this type of reasoning. Regarding students from technical specialties, they should be more aware of the process of thinking and problem solving. To achieve this, teachers should provide more guidance and support in approaching the tasks and to learn students how to use that knowledge for improvement of their strengths and decreasing the weaknesses. Students should be more aware of their learning processes and products as well as how to regulate those processes for more effective learning. Developing metacognition, it allows students to be successful learners. Teachers should insist on awareness about the cognitive processes involved in learning, because it can lead to long-term learning success. But to achieve it, the success should be sustained from two directions: to use metacognitive knowledge (to strengthen the knowledge of cognitive processes and strategies), and to develop metacognitive regulation through practical experience in using both cognitive and metacognitive strategies and evaluating the outcomes of their efforts. Only providing knowledge without practical experience or vice versa does not seem to be sufficient for the development of metacognitive control. Also, teachers should make the students to realize that their decisions can be based on not just characteristics of the input problem, but a good choice involves knowledge about algorithm performance. Therefore, we believe that metacognition plays a critical role in successful learning, therefore it is closely related to authentic assessment and holistic learning.

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